(PRIVATE.)

REPORT of the Committee, appointed by the Council of the Royal Society, to consider the subject referred to in Mr. Stewart's Letter, relative to Mr. Babbage's Calculating Engine, and to report thereupon.

Your Committee, in this their Report, have no intention of entering into any consideration of the abstract mathematical principle on which the practicability of such a Machine as Mr. Babbage's relies, nor of its public utility when completed. They consider the former as not only sufficiently clear in itself, but as already admitted and acted on by the Council in their former proceedings. The latter they regard as obvious to every one who considers the immense advantage of accurate numerical Tables in all matters of calculation, especially in those which relate to astronomy and navigation, and the great variety and extent of those which it is professedly the object and within the compass of Mr. Babbage's Engine to calculate, and print with perfect accuracy.

The original object of the present Machine was to compute any tables which could be calculated by six orders of differences, and twelve figures in each, and sixteen figures in the table itself, in such a form that, by bestowing a very moderate degree of attention to their publication, it would be impossible for a single figure to be erroneous; and supposing any person employing them to entertain a doubt whether that moderate degree of care had been bestowed, he might in a short time himself verify the tables. The Machine was intended to produce the work stamped on plates of copper, or other proper material.

Besides the cheapness and celerity of calculation to be expected from it, the absolute accuracy of the printed results being one of the prominent pretensions of Mr. Babbage's undertaking, the attention of your Committee has been especially directed, both by careful examination of the work already executed and of the drawings, and by repeated conferences with Mr. Babbage to this point. And the result of their inquiry is, that such precautions appear to have been taken in every part of the contrivance and work which they have examined, and so fully aware does the inventor appear to be of every circumstance which may by possibility introduce error, that they have no hesitation in saying they believe these precautions effectual, and that whatever the Engine does it will do truly.

In the actual execution of the work they find that Mr. Babbage has made a progress, which, considering the very great difficulties to be overcome in an undertaking so novel, they regard as fully equalling any expectations that could reasonably have been formed; and that although several years have now elapsed since the first commencement, yet that when the necessity of constructing plans, sections, elevations, and working drawings of every part; that of constructing, and in many cases inventing, tools and machinery of great expense and complexity, (and in many instances of ingenious contrivances, and likely to prove useful for other purposes hereafter,) for forming with the requisite precision parts of the apparatus dissimilar to any used in ordinary mechanical works; that of making many previous trials to ascertain the validity of proposed movements; and that of altering, improving, and simplifying those already contrived and reduced to drawings; your Committee are so far from being surprised at the time it has occupied to bring it to its present state, that they feel more disposed to wonder it has been possible to accomplish so much.

The drawings form a large and most essential part of the work; they are executed with extraordinary care and precision, and may be regarded as among the best that have ever been constructed. On these all the contrivance has been bestowed, and all the alterations made, so that scarcely any work excepting drawing has been thrown away. When it is mentioned that upwards of 400 square feet of surface are covered with drawings, many of them of the most elaborate description, it will easily be understood that a very great expense of time, thought, and capital must have been incurred in producing them, but without which your Committee consider that success would have been impossible.

Nearly the whole of this department of the work (according to Mr. Babbage's statements, probably nine-tenths) is completed, and what remains is of a nature to afford no difficulty on the score of contrivance; so that there is no reason why the execution of the work (hitherto necessarily retarded till the completion of the drawings) could not now proceed with rapidity; and according to what the Committee have been enabled to gather from Mr. Babbage's statements and their own observations, and supposing no unexpected cause of delay, they regard a further period of three years as probably sufficient for its completion.

In judging of the adequacy of Mr. Babbage's work to complete the objects for which it was intended, there are two distinct questions—the adequacy of the contrivance, and that of the execution. On the former point every explanation has been afforded by Mr. Babbage, and both the drawings and the work executed have been unreservedly subjected to their discussion, and have been such as to excite a well-grounded confidence. The movements are combined with all the skill and system which the most experienced workmanship could suggest.

But in so complex a work, in which interrupted motions are propagated simultaneously along a great variety of trains of mechanism, it might be apprehended that obstacles would occur, or even incompatibilities arise, from the impracticability of foreseeing all the possible combinations of the parts, and of which, in a mere inspection, your Committee could not be expected to form a judgment. But this doubt, should it arise, your Committee consider as fully and satisfactorily removed by the constant employment by Mr. Babbage of a system of mechanical notation, devised by himself, and explained in a paper in the Transactions of this Society; which places at every instant the progress of motion through all parts of this or any other mechanism distinctly in view, and, by an exact tabulation of the times required for all the movements, renders it easy to avoid all danger of two contradictory impulses arriving at the same instant at any part.

Of the adequacy of the machinery to work under all the friction and strain to which it can ever be fairly exposed, and of its durability, your Committee have not the least doubt. Great precautions are taken to prevent the wear of the parts by friction; and the strength, solidity, and equilibrium, in the whole apparatus, ensure it from all danger on the score of violence or constant wear.

It ought also constantly to be borne in mind, that in all those parts of the Machine where the nicest precision is required, the wheelwork only brings them by a first approximation (though a very nice one) to their destined places; they are then settled into accurate adjustment by peculiar contrivances, which admit of no shake or latitude of any kind.

The Machine consists essentially of two parts, a calculating part and a printing part. These are both equally essential to the fulfilment of Mr. Babbage's views; for the whole advantage would be lost, if the computations made by the Machine were copied off by human hands and transferred to type by the usual process. The actual work of the calculating part is in great measure constructed, although not put together, a portion only having been temporarily fitted up for the inspection of the Committee; and from its admirable workmanship they have been able to form a confident opinion that it will execute the work expected from it. At the same time, the Committee cannot but observe that, had inferior workmanship been resorted to,

such is the number and complexity of the parts, and such the manner in which they are fitted together, the success of the undertaking would have been hazarded; and they regard as extremely judicious, although, of course, very expensive, Mr. Babbage's determination to admit of nothing but the very best and most finished work in every part; a contrary course would have been false economy, and might have led to the loss of the whole capital expended on it.

In the printing part less progress has been made in actual execution than in the calculating. The reason being the greater difficulty of its contrivance, not for transferring the computations from the calculating part to the copper, or other plate ultimately destined to receive them, but for giving to the plate itself the number and variety of movements which the forms adopted in printed tables may call for in practice. The movements necessary for effecting this, being entirely such as might at any time be decided on, were purposely allowed to stand over till the more difficult parts should be fully developed. Taking the calculating and the printing part together, and regarding the tools and machinery already erected as available for the performance of what remains, the Committee regard it as not improbable that three-fifths of the work may be already completed, but they cannot be expected to state this with any degree of certainty.

With regard to the expense incurred, and likely to be incurred, Mr. Babbage states the sum already expended by him at £6000; (see) £1000 of which he states to have been laid out in preliminary trials, which have not formed an object of inquiry with the Committee. Taking into consideration the extent of the work and drawings, which they have examined, and judging entirely from the general knowledge of the cost of these and similar works, which the professional experience of several individuals of the Committee has enabled them to acquire, they are no way surprised at the outlay thus stated to have been incurred. With regard to the future cost, they have, of course, less means of judging than of the past,—of which they see the results, and the tools with which they have been produced. A probable conjecture might be grounded on the proportion of $\frac{3}{5}$, assumed as the proportion of the work already done; but this would require to be received with very great latitude.

Finally, taking into consideration all that has been already said, and relying not less on the talent and skill displayed by Mr. Babbage as a mechanician, in the prosecution of this arduous undertaking, for what remains,—than on the matured and digested plan and admirable execution of what is accomplished, your Committee have no hesitation in giving it as their opinion, that "in the present state of Mr. Babbage's Engine, they do regard it as likely to fulfil the expectations entertained of it by its inventor."

(Signed) I. T. W. HERSCHEL,
Chairman.

REPORT OF COMMITTEE

OF

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